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Siegel

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[54] **PERFORATION APPARATUS AND METHOD FOR USE WITH SEALING DEVICES**

[75] Inventor: **Martin Siegel,** Englewood Cliff, N.J.

[73] Assignee: **Weldotron of Delaware, Inc.,** Wilmington, Del.

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[51] **Int. Cl.**[6] **B26F 1/24**

[52] **U.S. Cl.** **83/30;** 83/18; 83/175; 83/660

[58] **Field of Search** 83/660, 669, 175, 18, 83/30

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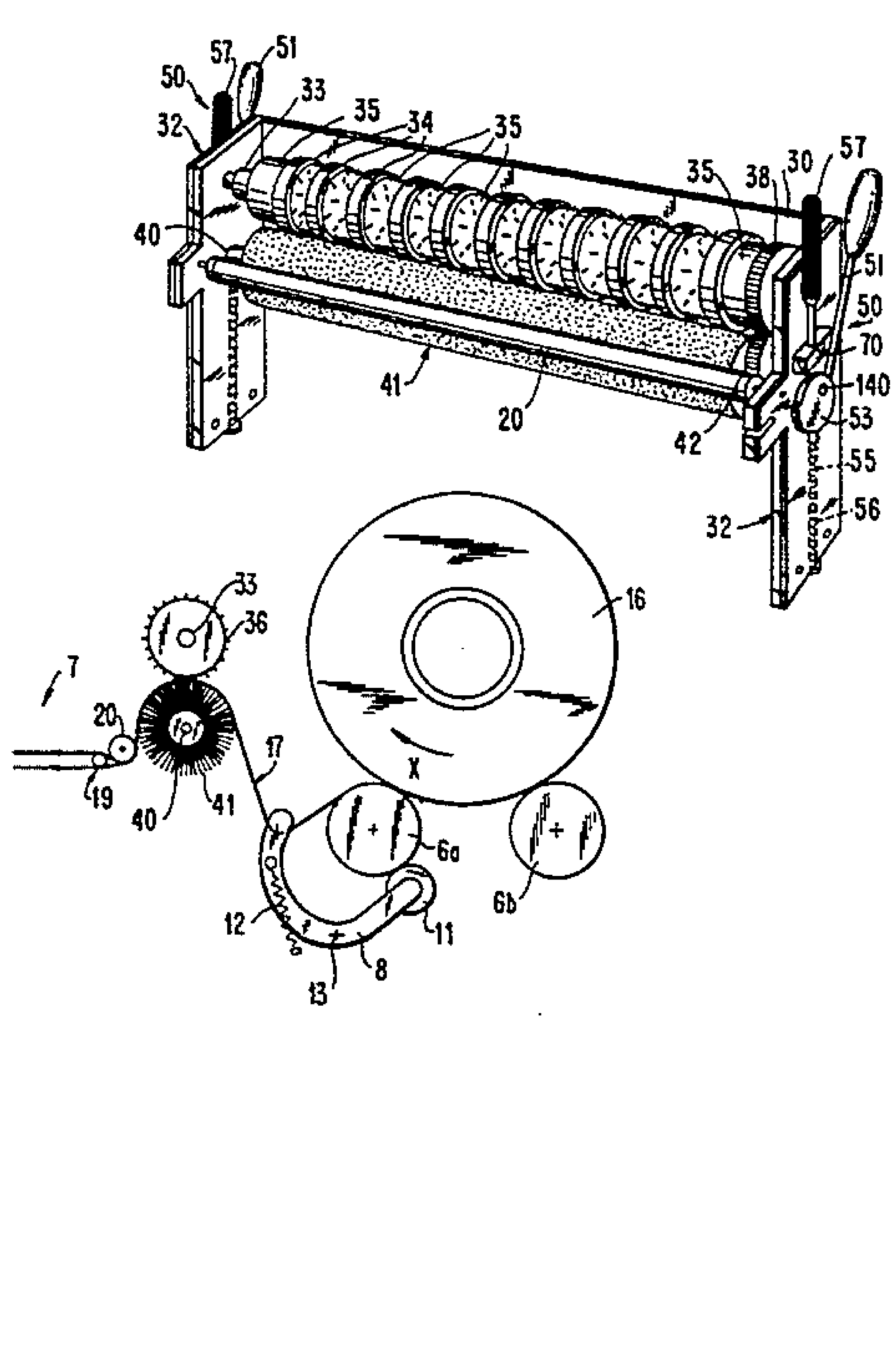
Primary Examiner—Rinaldi I. Rada
Attorney, Agent, or Firm—Davis Hoxie Faithfull & Hapgood

[57] **ABSTRACT**

A perforating device for punching pores in shrink-wrap film as the film moves along a film path is described. A biasing apparatus is used to bias the film towards a tension-creating apparatus and a microperforator apparatus so that pores can be punched in the film. An embodiment of the invention uses microperforator pin wheels, having a plurality of conically-shaped pins, and gripper wheels connected to a microperforator shaft. A rotary brush is connected to a rotary brush shaft. Shrink-wrap film is threaded between the microperforator shaft and the rotary brush shaft, and then pulled by an operator to wrap a package. The rotary brush biases the film towards the microperforator pin wheels and the gripper wheels, so that the pins on the micoperforator pin wheels puncture the film as it is being pulled. The rotary brush shaft can be adjusted to permit film to be threaded, and to control the size of the pores to be punched into the film. In addition, the amount and location of the microperforator pin wheels and the gripper wheels connected to the microperforator shaft can be changed so that the device can be customized to provide different patterns of pores as well as to control the amount of pores to be punched.

17 Claims, 9 Drawing Sheets



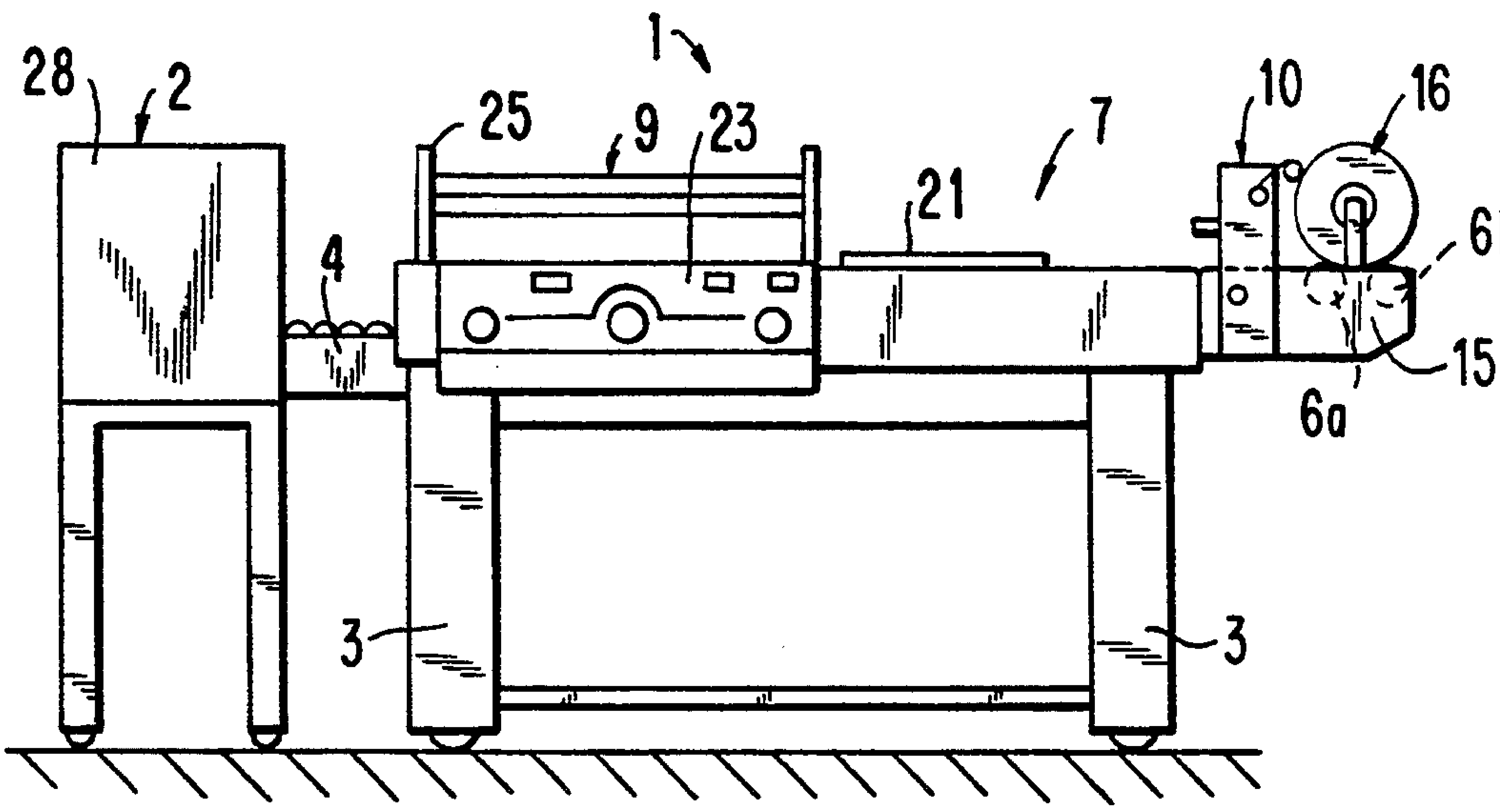

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FIG. 1A

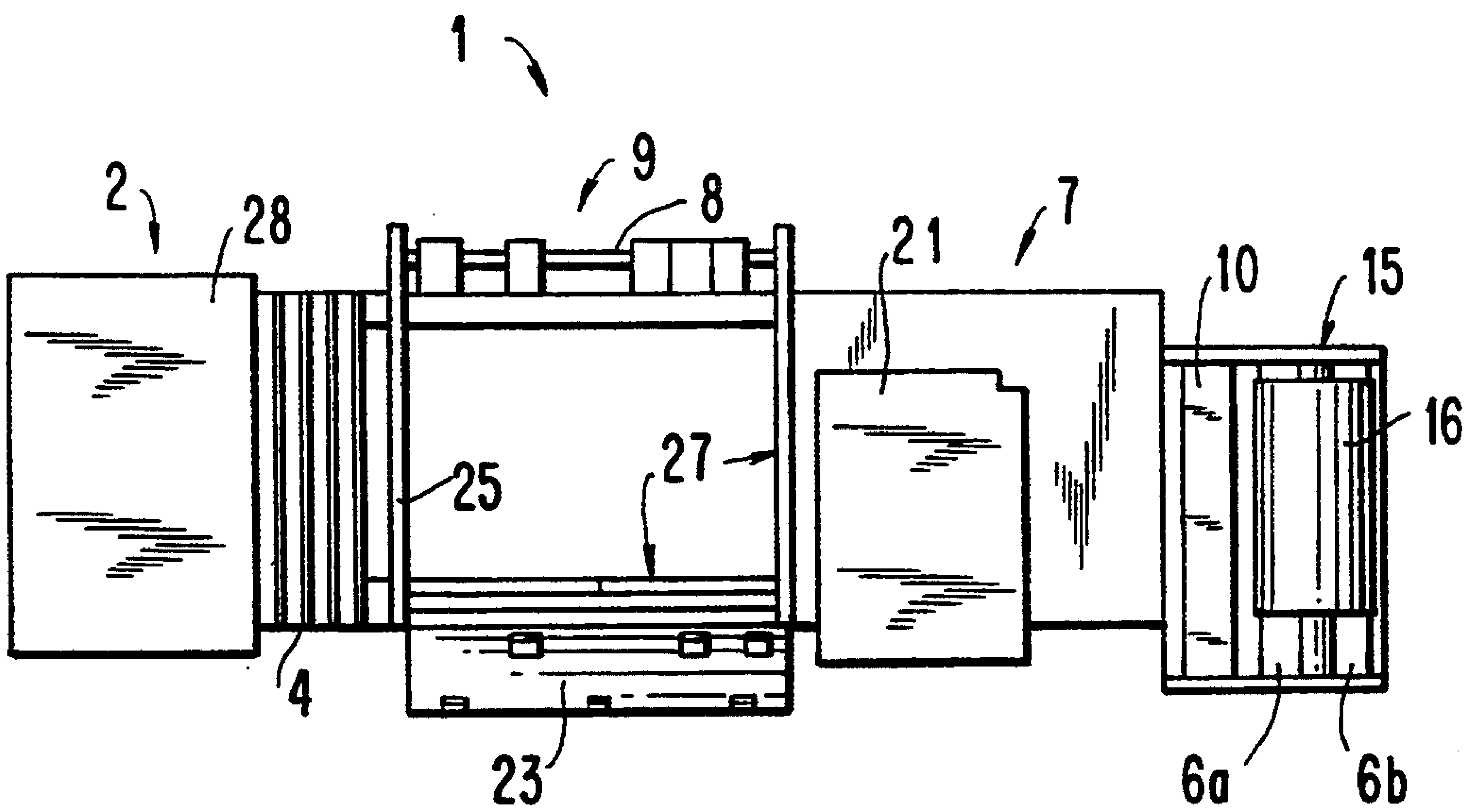
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FIG. 1B

FIG. 2A

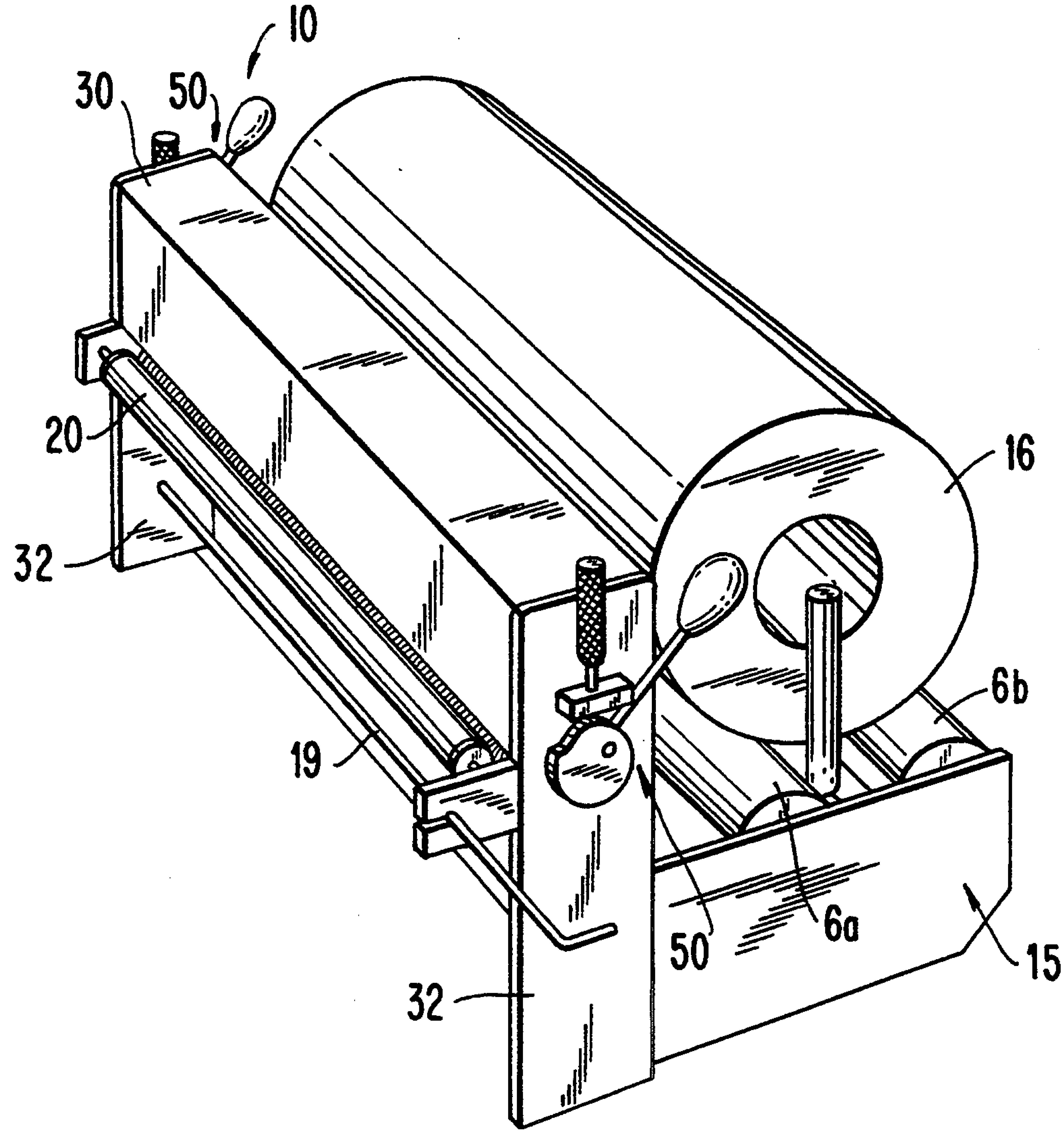
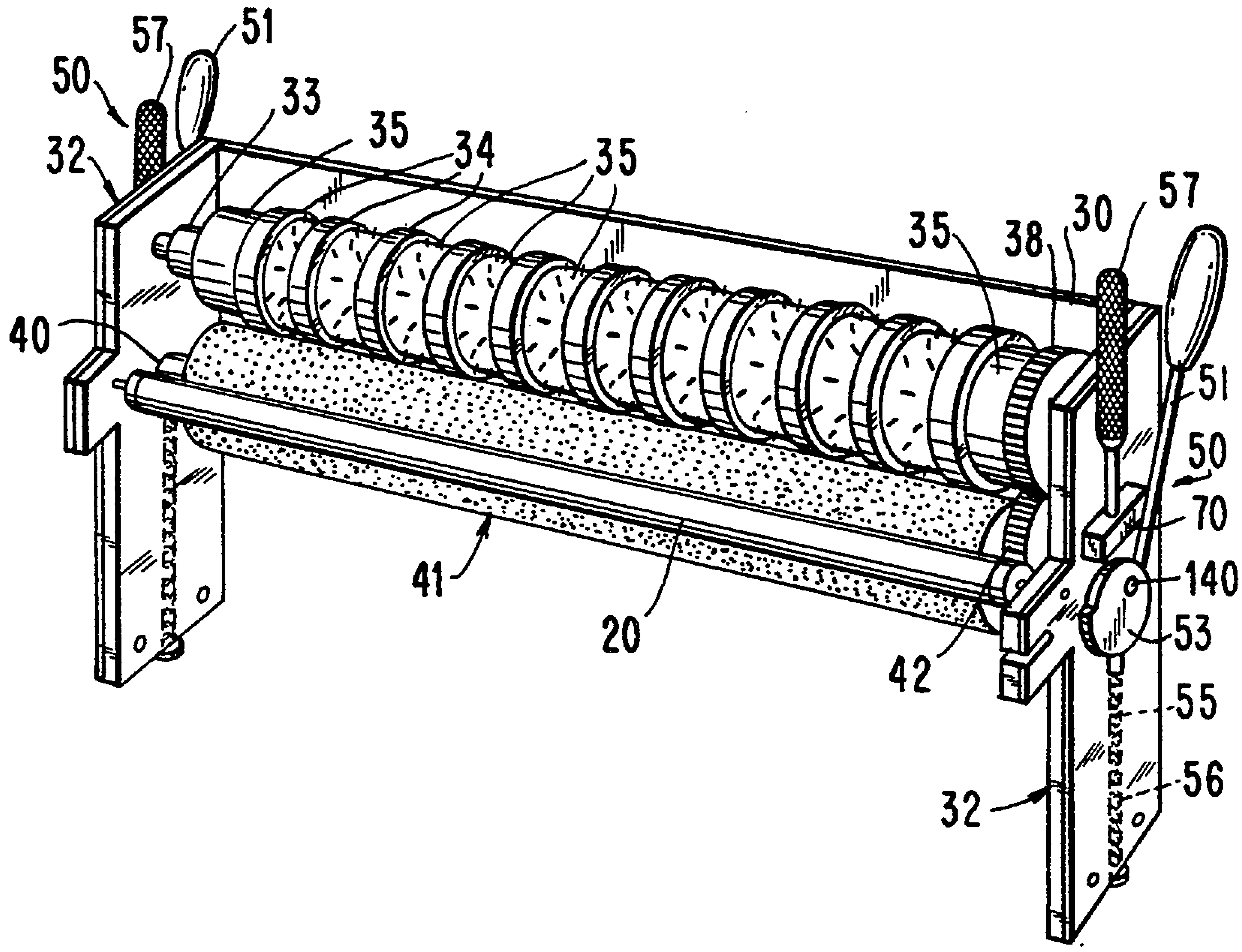


FIG. 2B



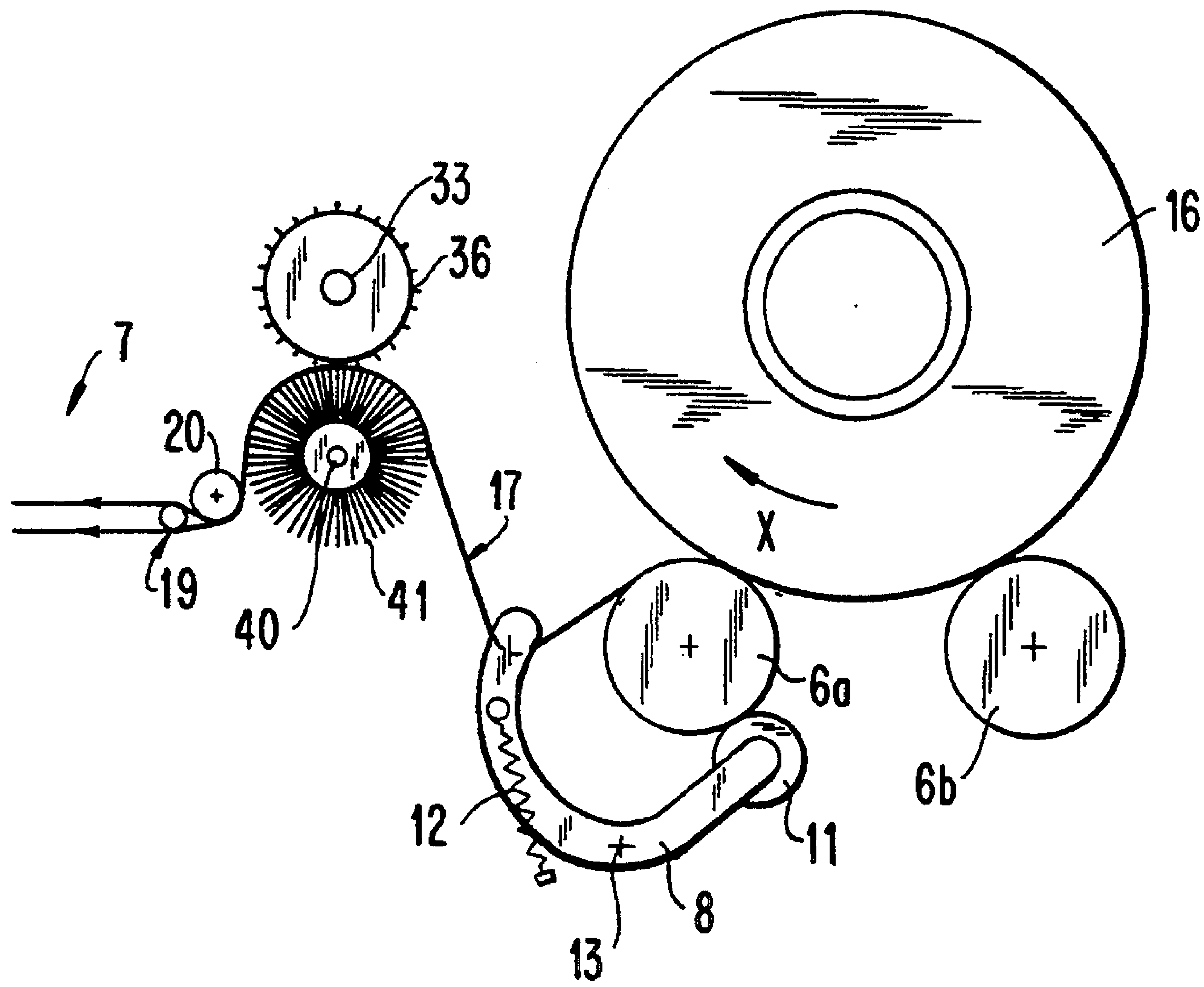

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FIG. 3

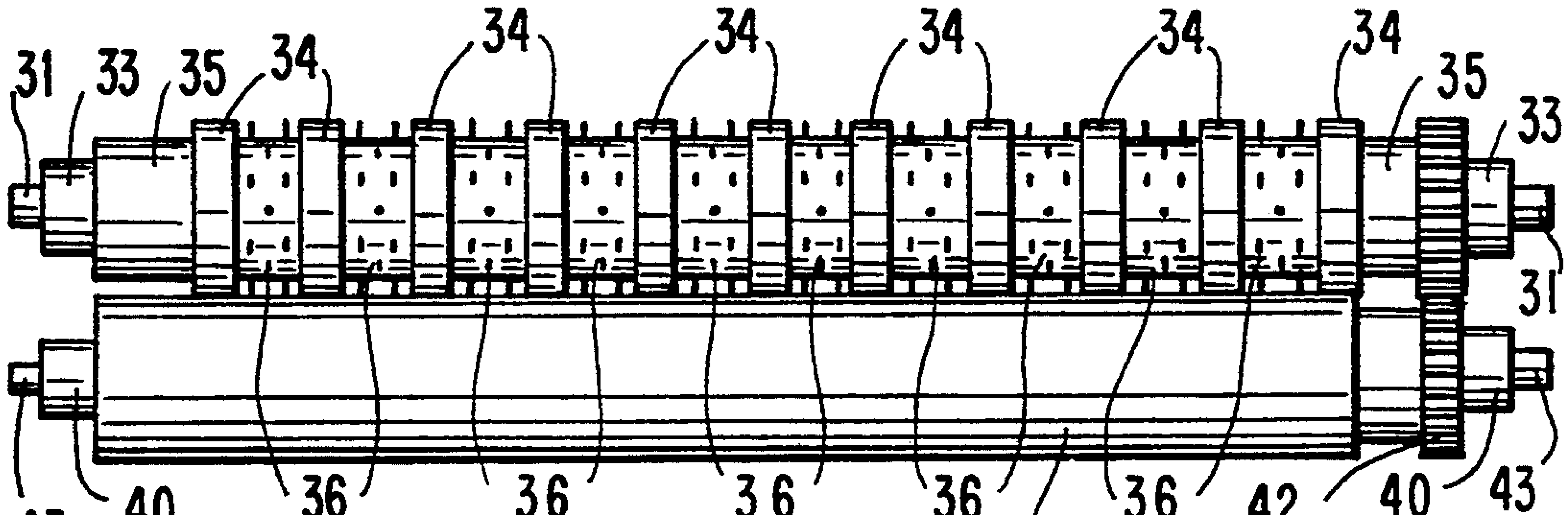
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FIG. 4

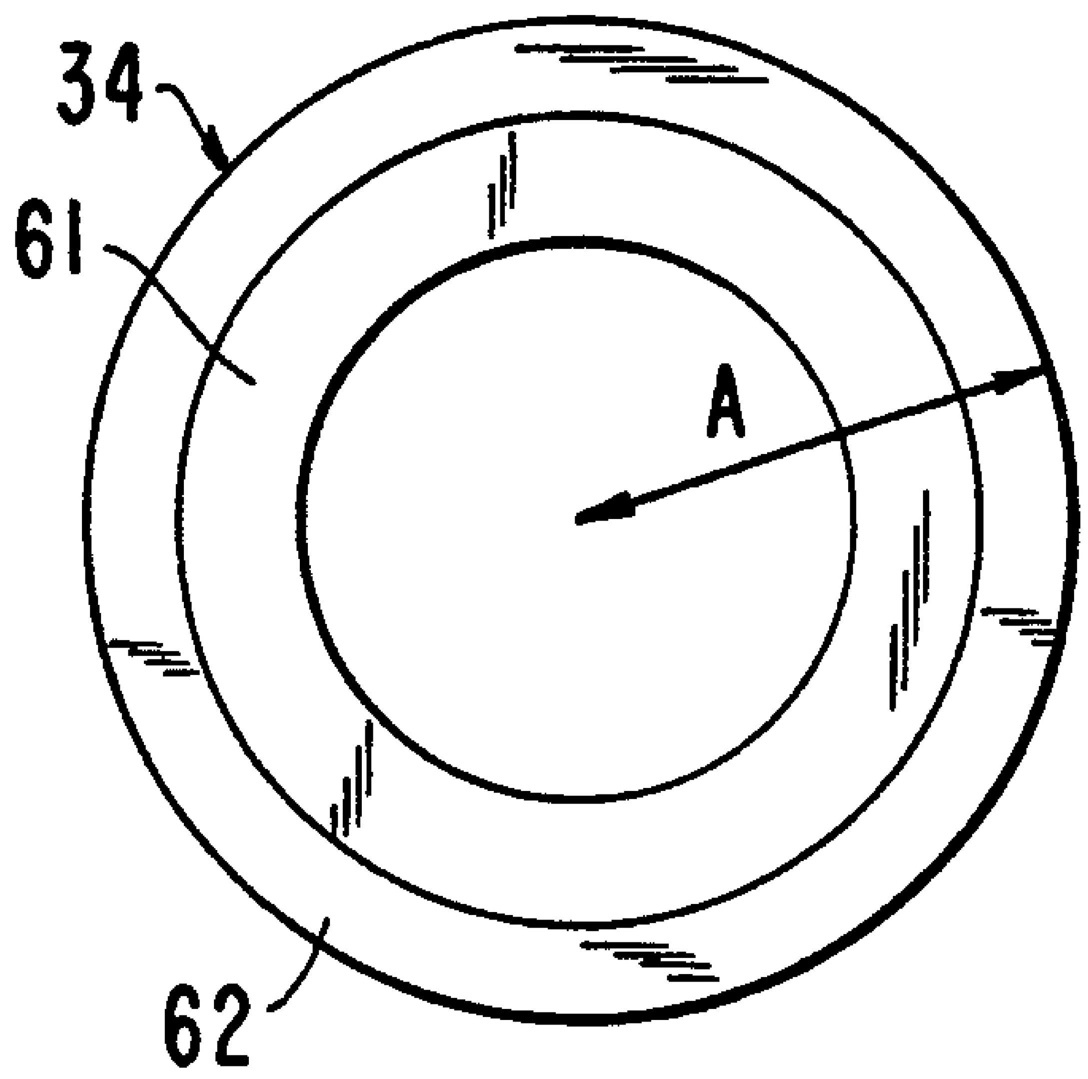


FIG. 5A

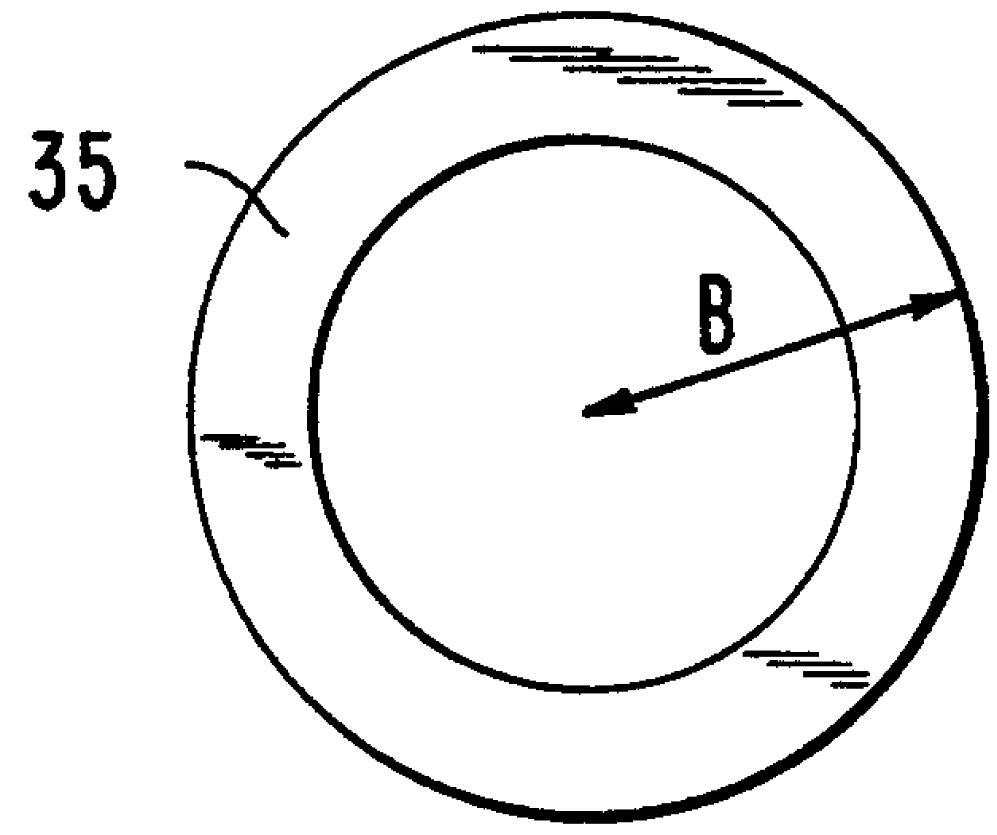


FIG. 5B

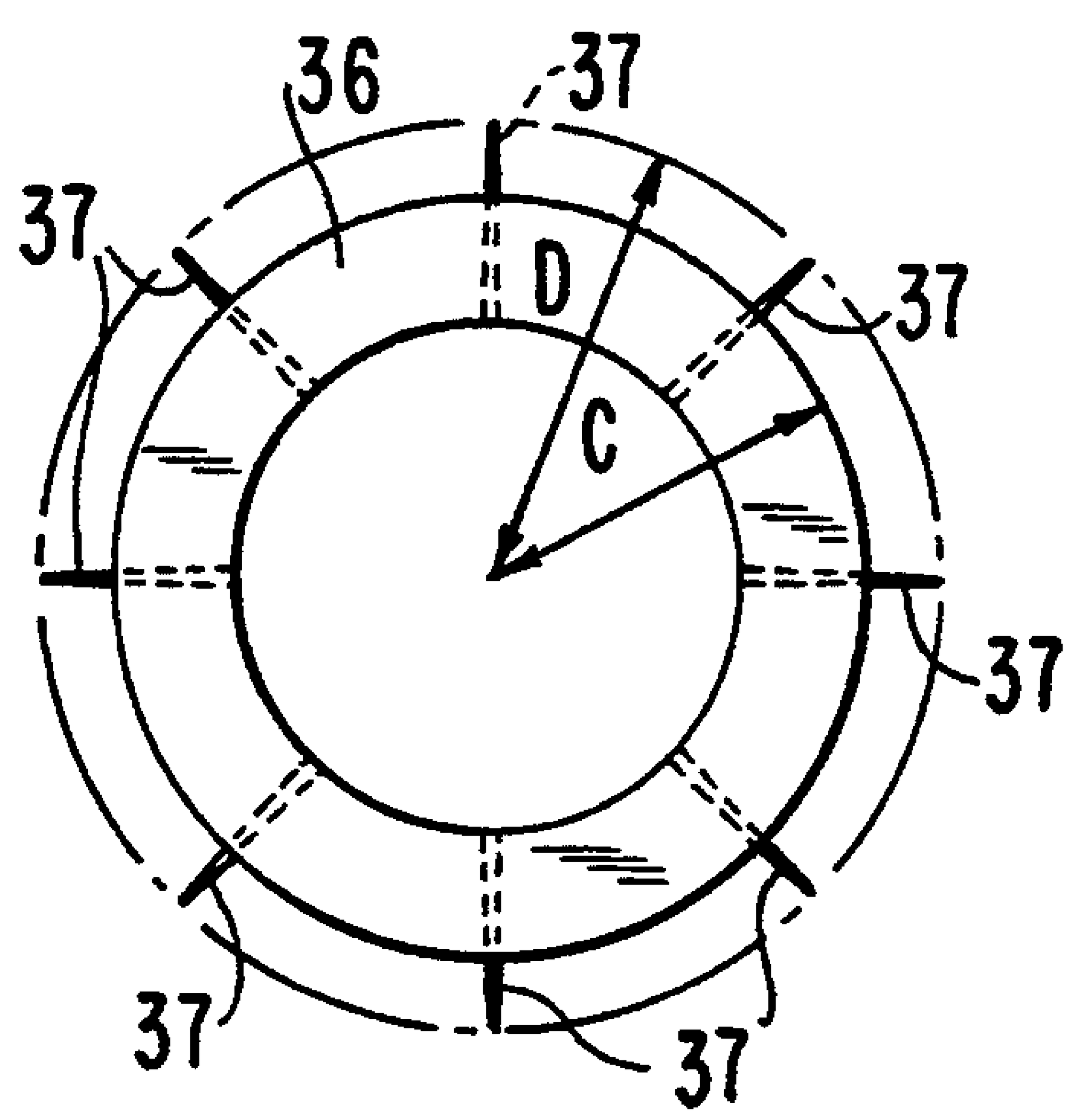


FIG. 5C

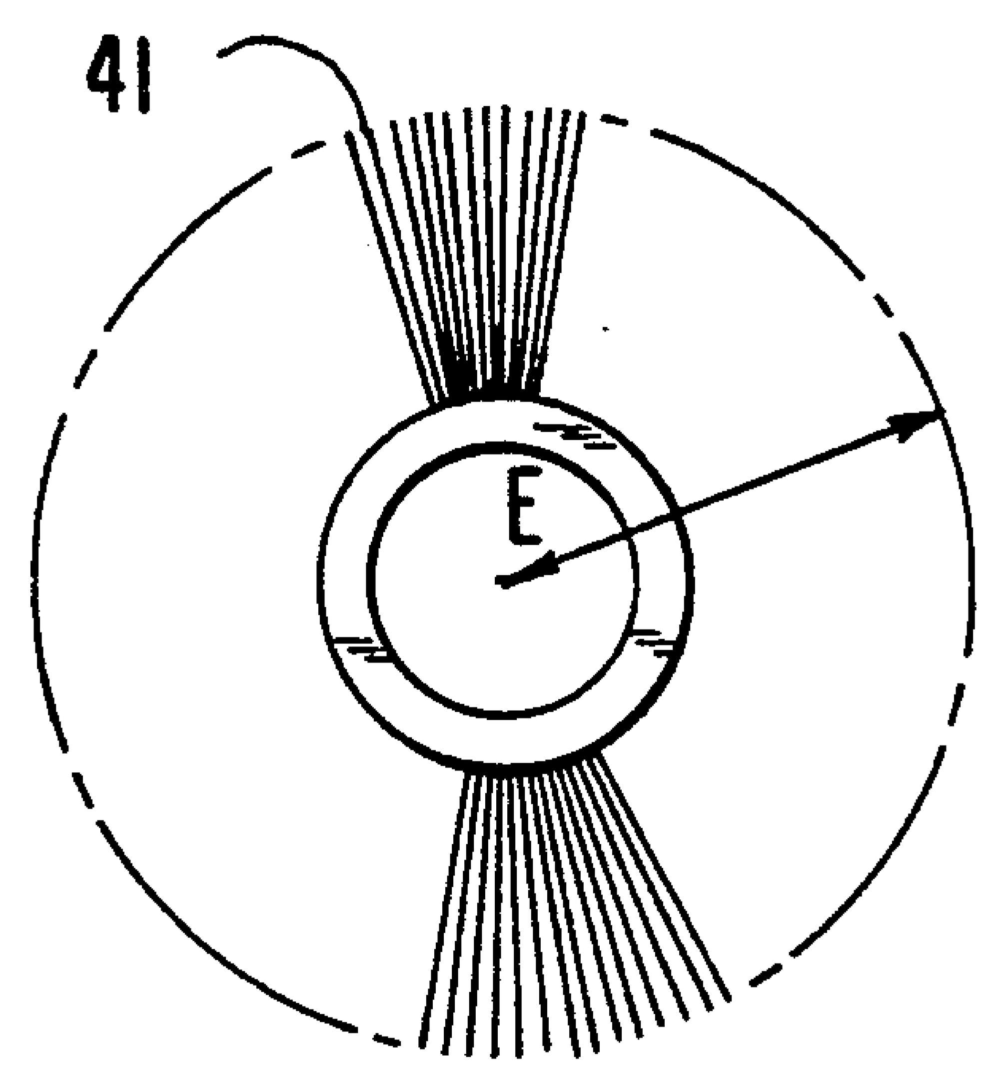


FIG. 5D

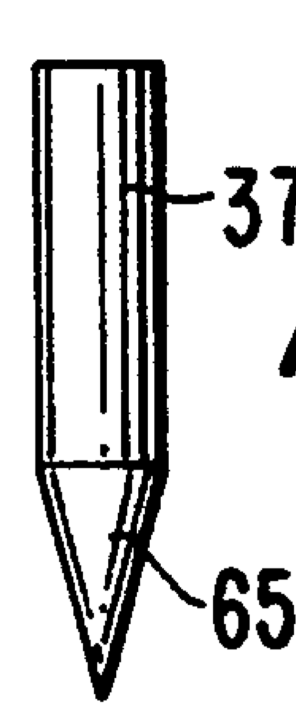


FIG. 5E

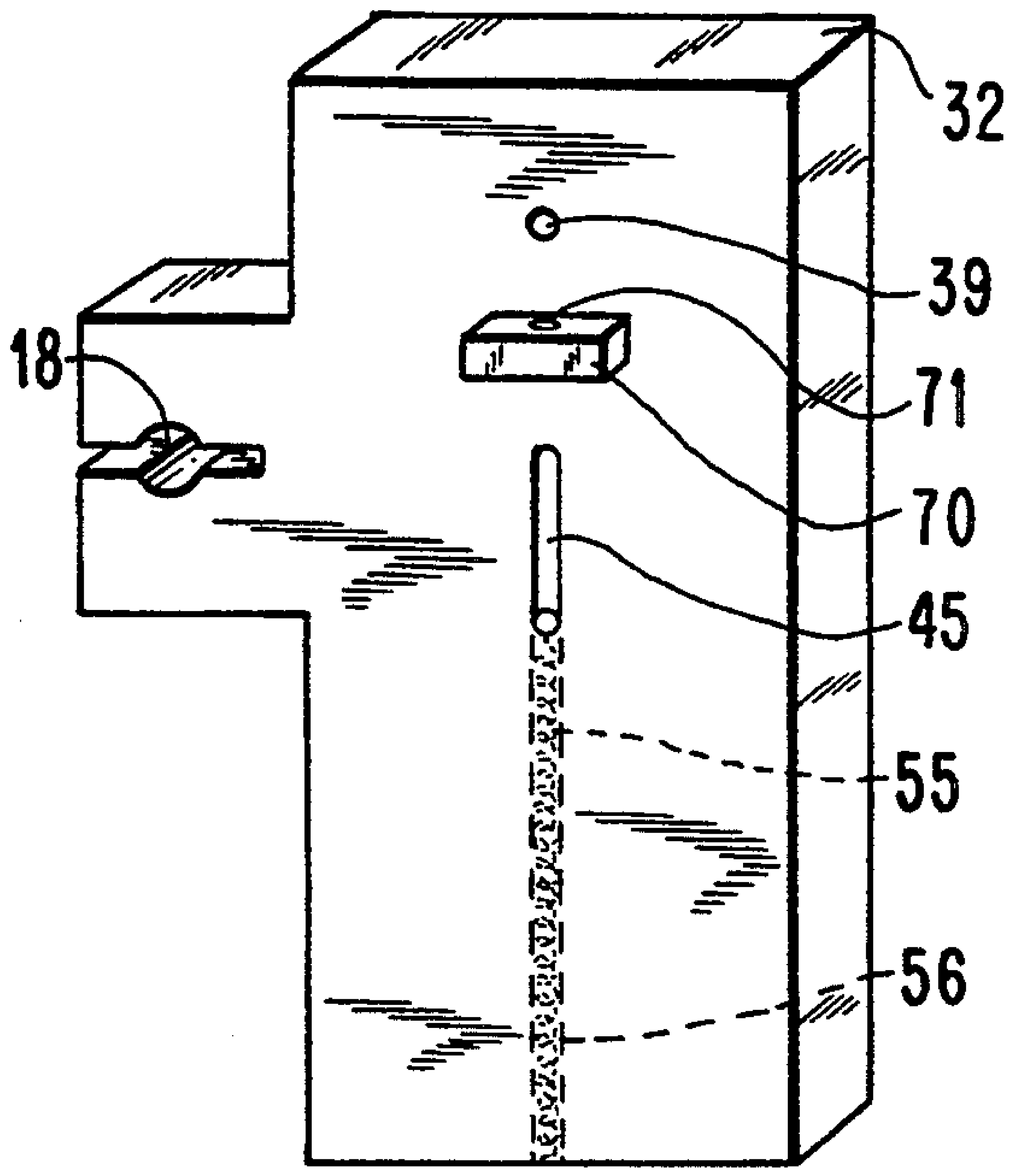


FIG. 6A

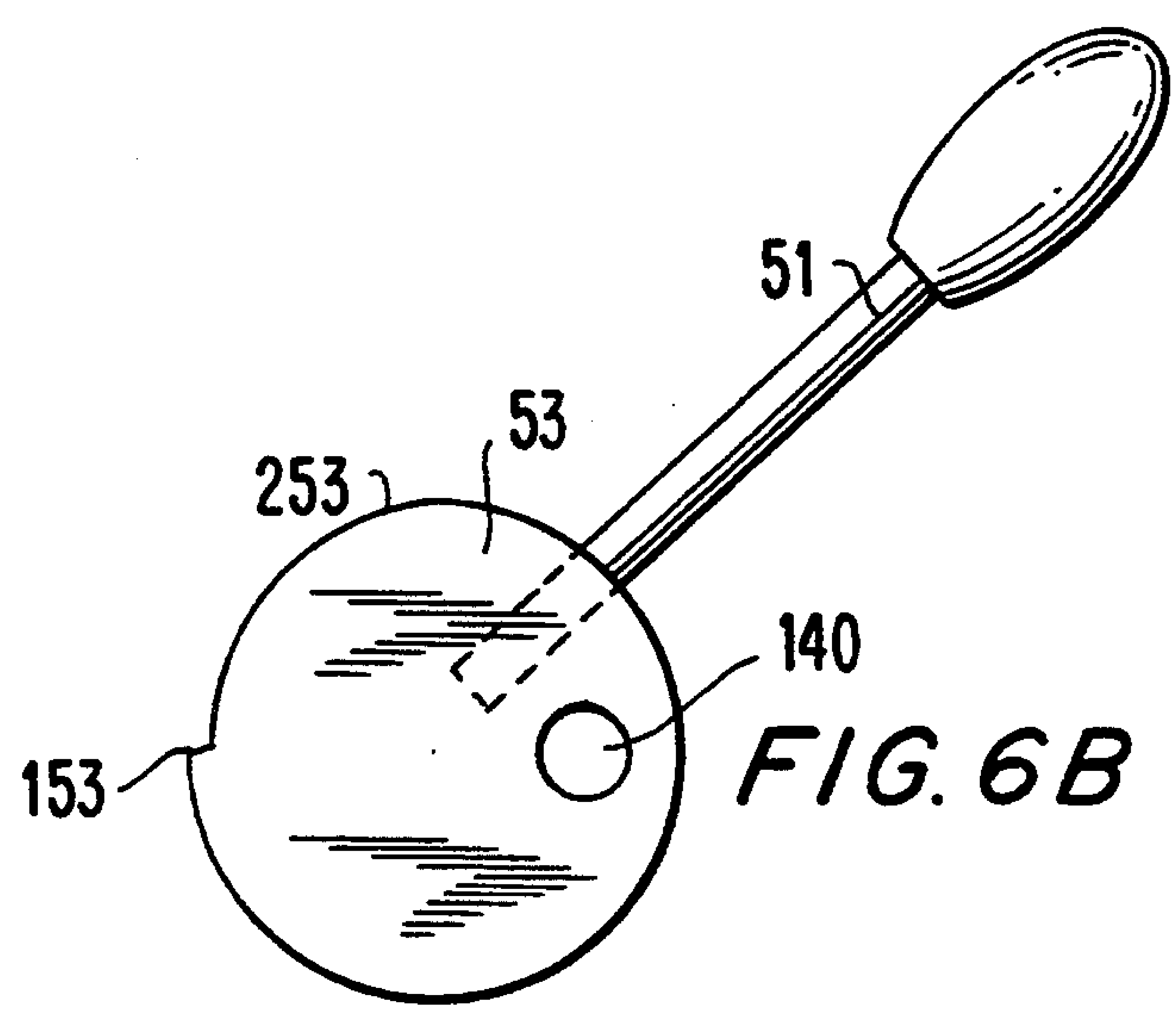


FIG. 6B

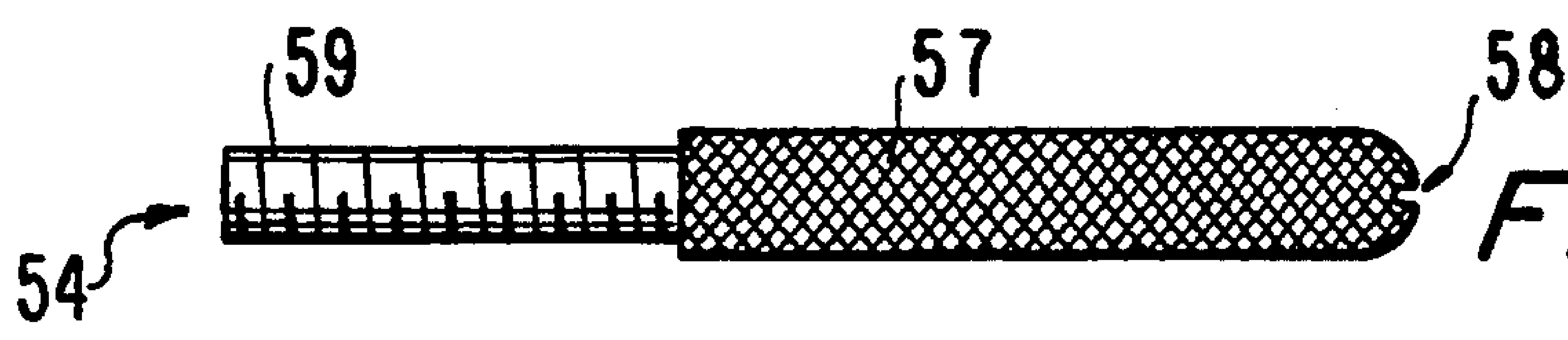


FIG. 6C

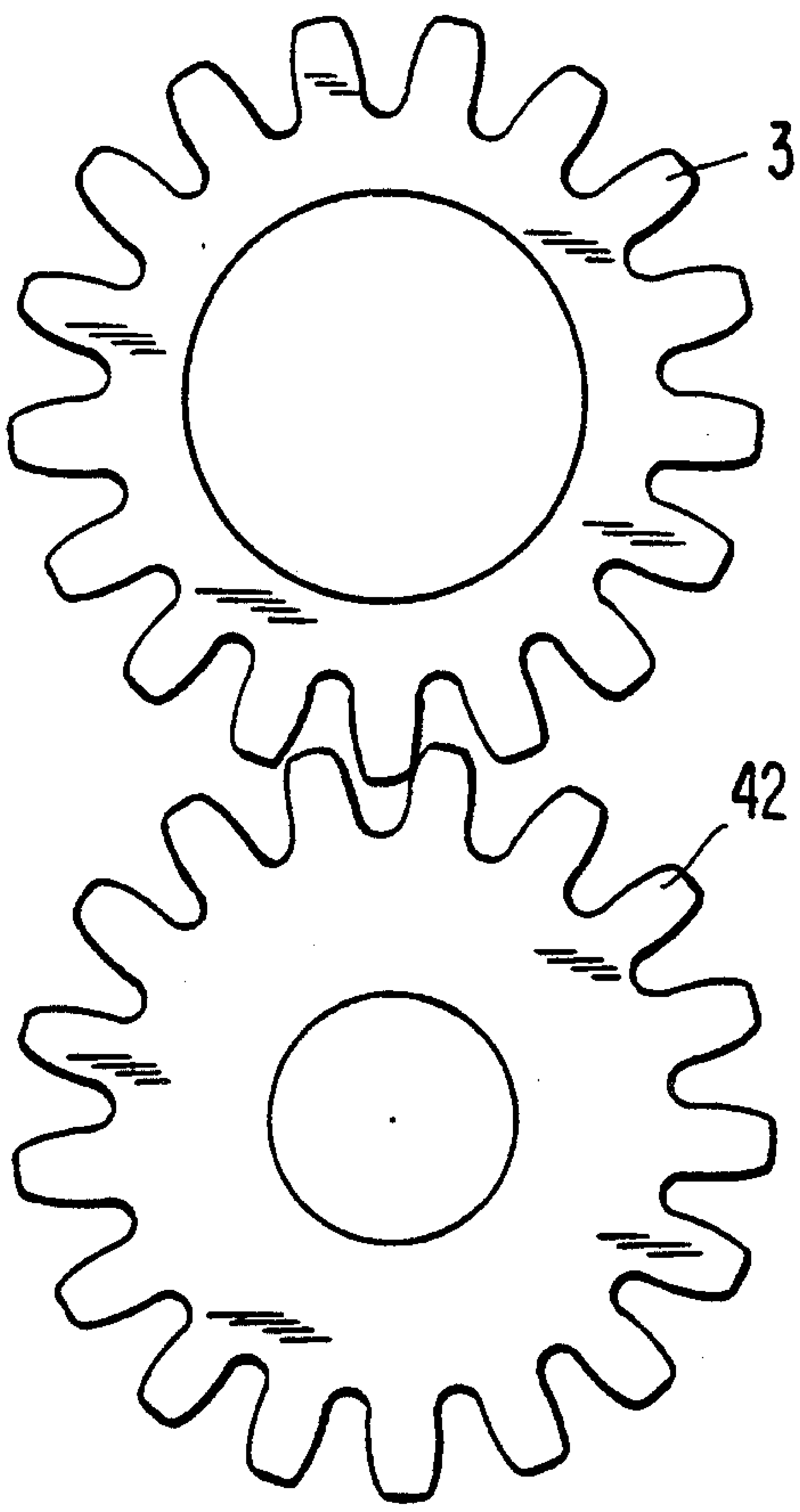


FIG. 7A

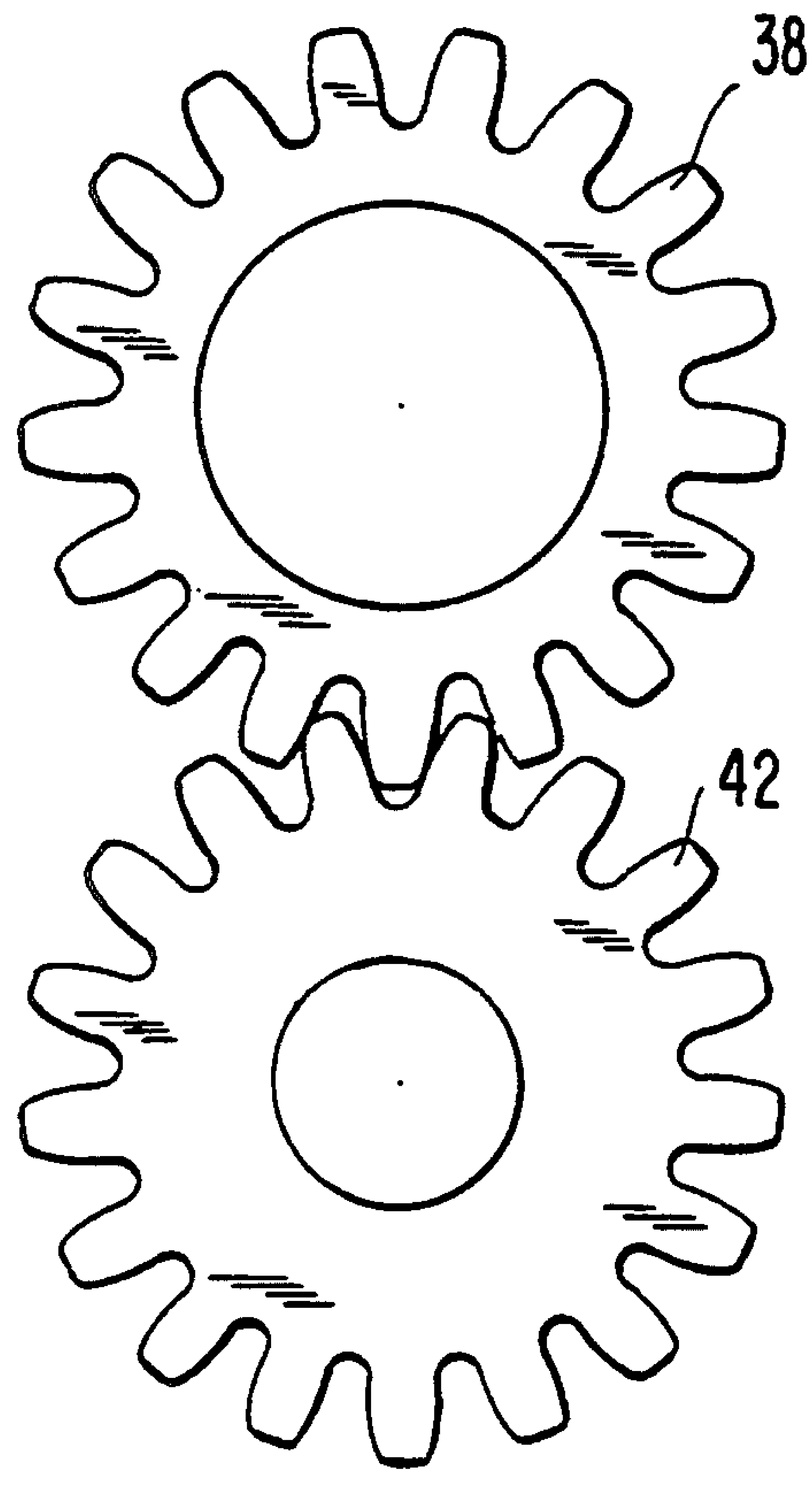


FIG. 7B

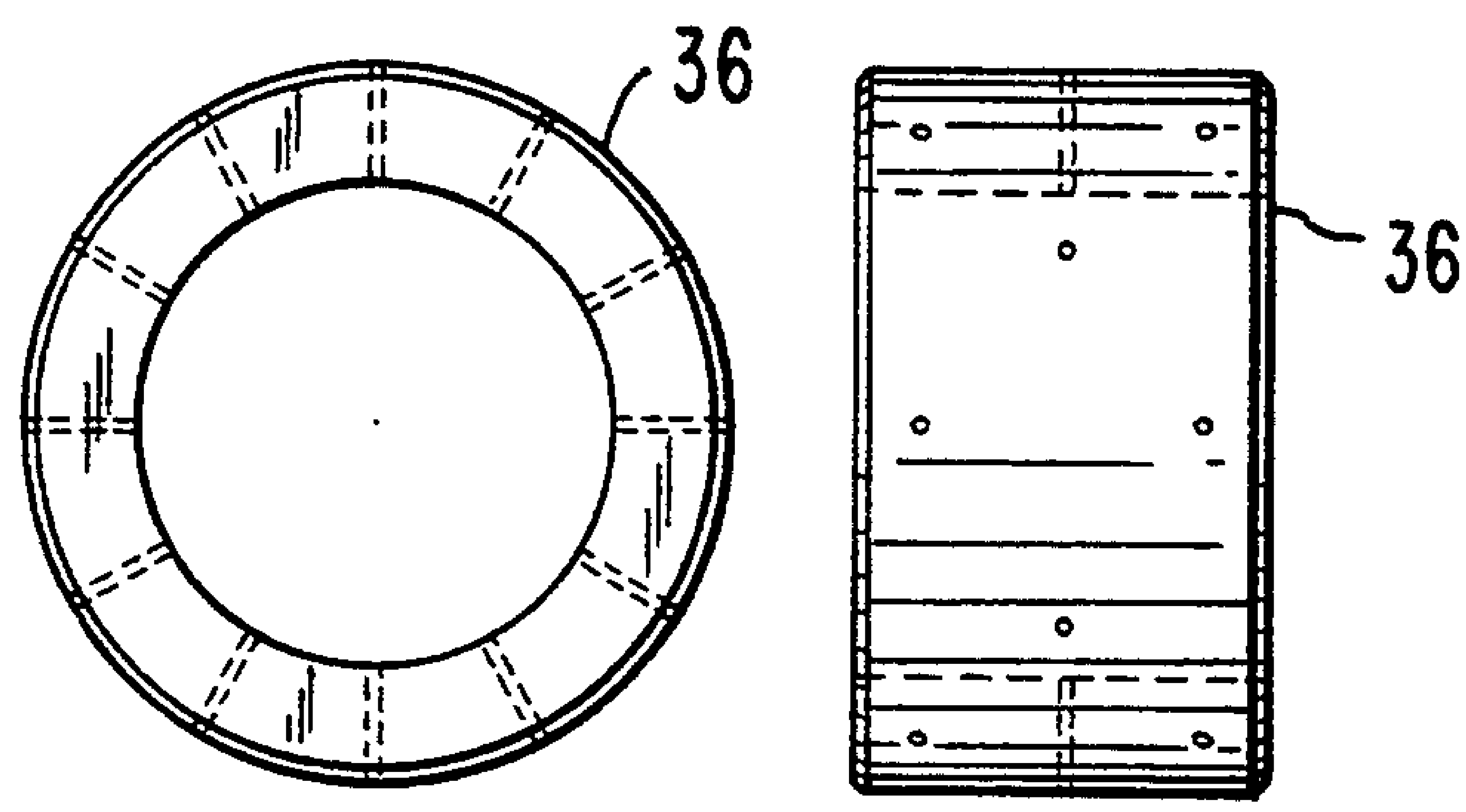


FIG. 8A

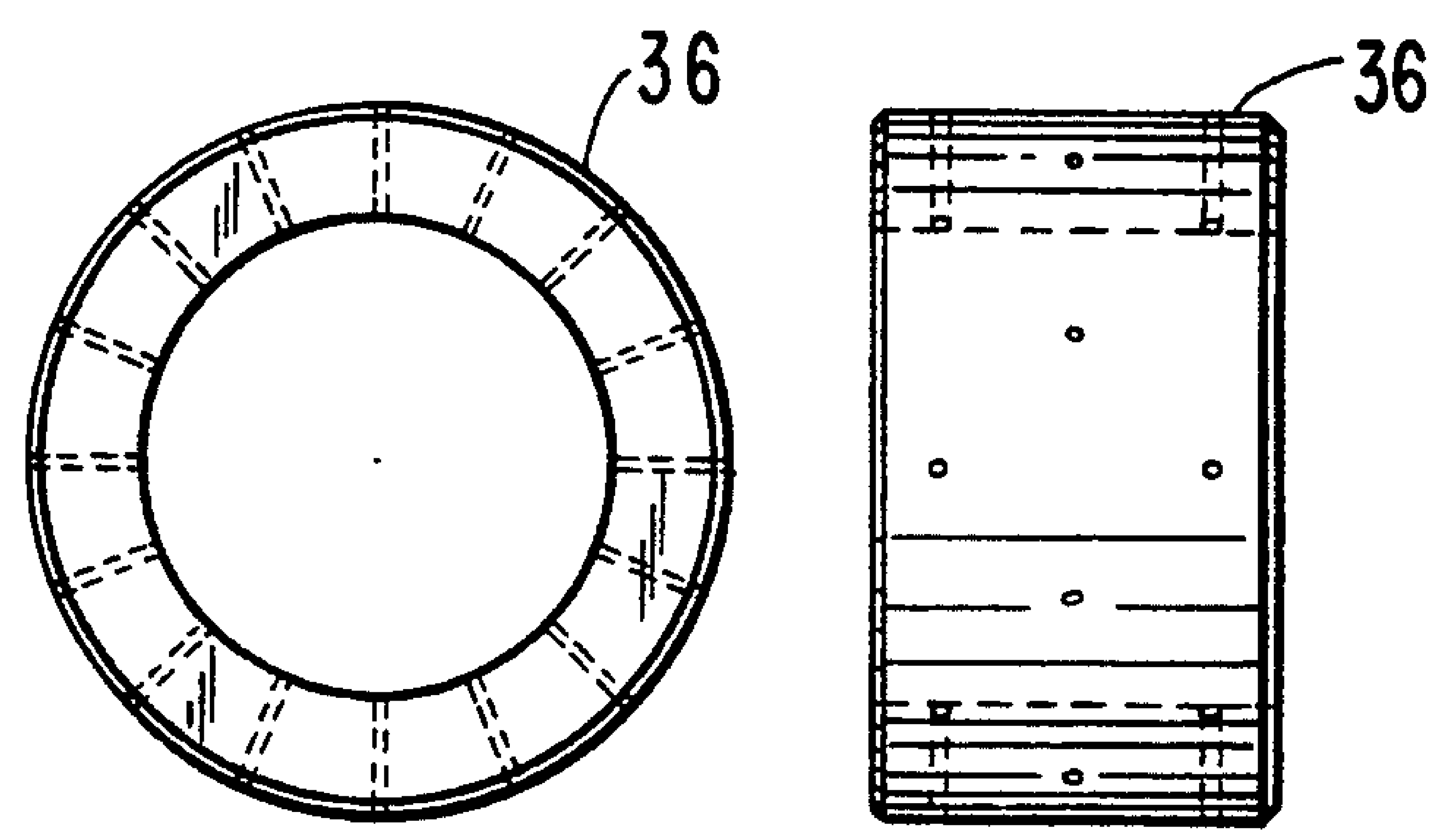


FIG. 8B

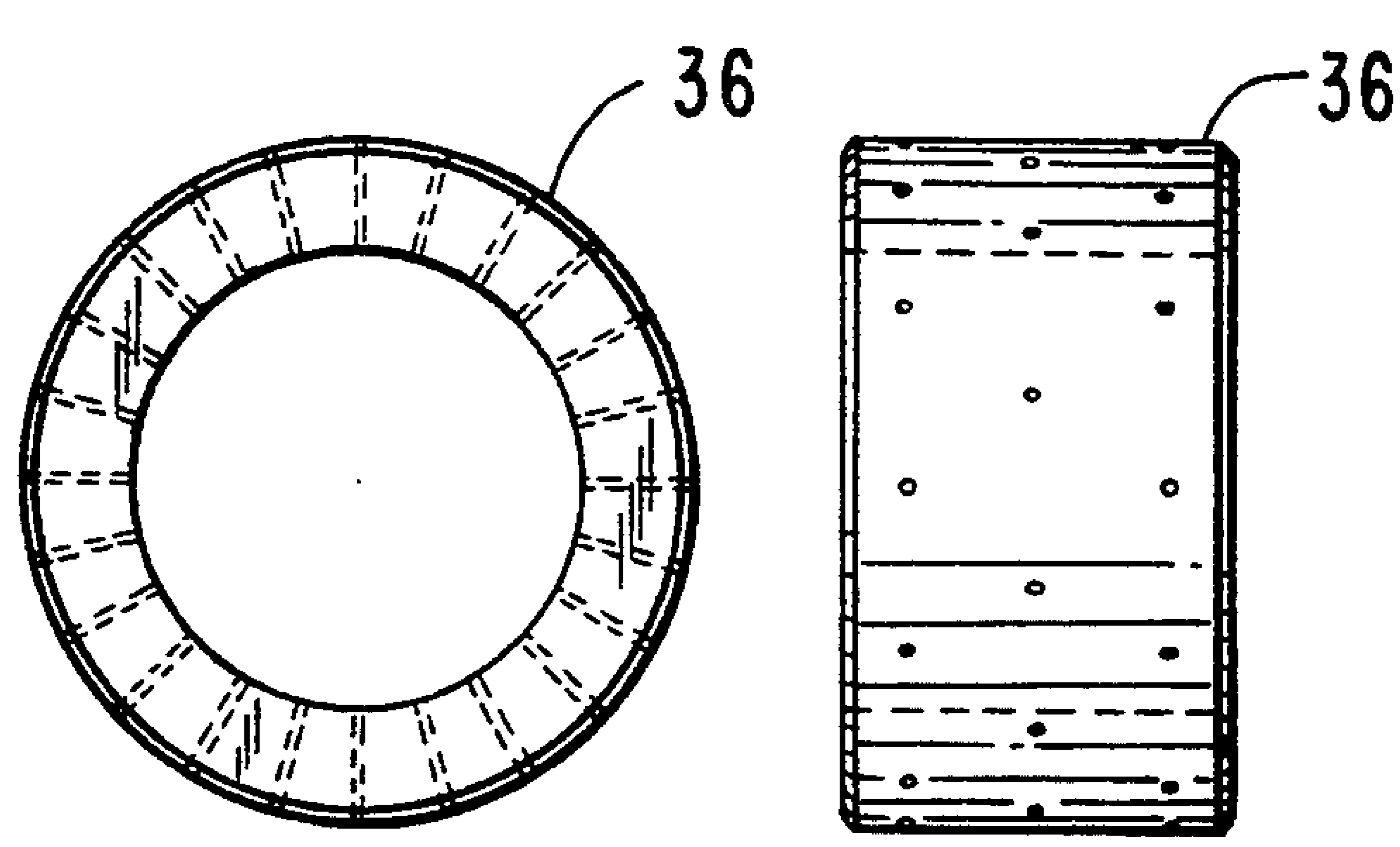
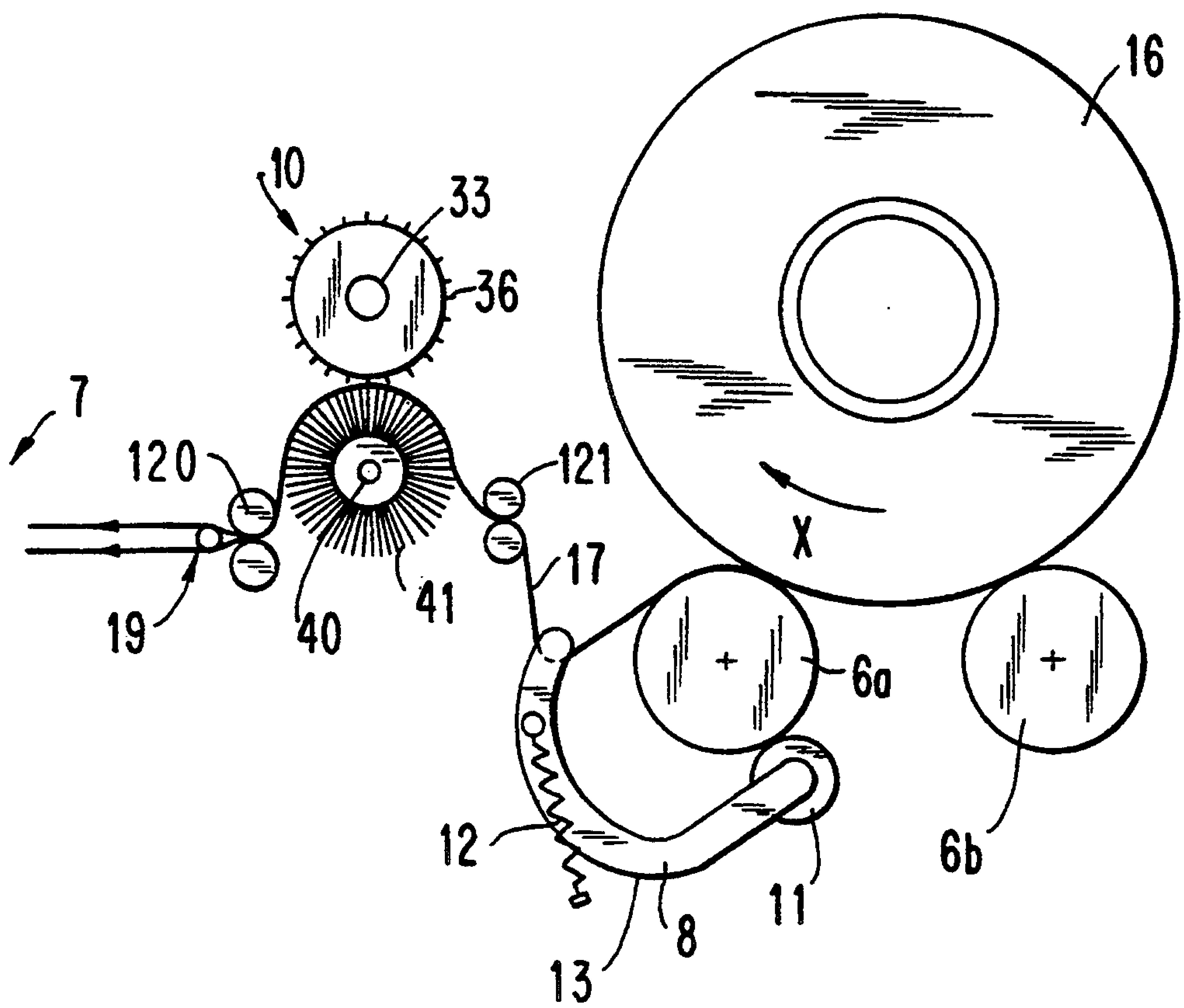


FIG. 8C

FIG. 9



PERFORATION APPARATUS AND METHOD FOR USE WITH SEALING DEVICES

FIELD OF THE INVENTION

The present invention relates to the art of heat-shrink packaging devices such as L-sealers, hermetic sealers and the like. In particular, the present invention is an apparatus and method for making pores in shrink-wrap used to wrap items in a heat-shrink-wrapping system.

BACKGROUND OF THE INVENTION

In recent years, it has become increasingly popular and commonplace to package many commercial articles in close-fitting transparent film. The transparent film is commonly known as shrink-wrap and has a characteristic of shrinking to conform to the item when exposed to heat.

Shrink packaging is a process in which an item is loosely wrapped in a shrink film and subjected to controlled heat by passing the package through a heat-shrink tunnel. The shrink films are typically supplied on rolls and are usually comprised of either polyolefins, PVC or polyethylene, each of which has the characteristic of having been stretched as part of the film production process.

Shrink films are designed to shrink when exposed to heat and will conform tightly around a product after the shrinking process. However, air which is trapped within the package during the sealing process must be permitted to escape at the proper rate during the shrinking process or else the shrink film will not shrink properly. Failure to provide adequate ventilation can result in a "ballooning effect" which occurs when all the air cannot escape during shrinking. Excessive ballooning can cause the shrink film to tear, cause the shrink film to wrinkle as air gradually and unevenly escapes, or create "dog ears" where the corners of the package are located. However, some ballooning is required because, if the film shrinks too quickly, it contacts the relatively cold item at points before shrinking is complete which may produce wrinkling. The packaging industry requires shrink-wrapped packages to be tightly wrapped without any tears and a minimum of wrinkling, since a consumer is less likely to buy an item which appears to be poorly wrapped. Consequently, it is highly desirable that heat-shrink film be perforated to permit exhaust at the proper rate.

To permit exhaust of the air that is trapped inside the package during the shrinking process, at least one vent hole is provided. Prior art shrink-wrapping systems added such vent holes to the shrink film by one or more of a variety of methods, including punching the film with an electric or pneumatic punching die, or creating a hole by using an electric arc, a hole burner or a rotary pin perforator. The vent holes created in these ways were usually relatively large in size.

One problem experienced by the prior art shrink-wrapping systems concerned the positioning of the vent hole. If the vent hole was located such that trapped air could not escape fast enough, the excessive ballooning effect discussed above occurred. Further, air could become trapped between the edges of the item and the shrinking film. If the hole was not located in that section of film, the trapped air might cause the film seal to burst or cause the film to tear. Further, the relatively large hole needed to permit entrapped air to escape during the shrinking process often appeared unsightly in the finished product. In addition, because of the large size of the hole, a possibility of future contamination of the package existed, especially with respect to shrink-wrapped food products. Yet further, the vent hole sometimes induced tearing of the shrink film which destroyed the wrapping around the package because all of the trapped air was forced out of a few holes.

To reduce some of these difficulties, the temperature in the heat shrink tunnel was often increased. Although increasing the temperature reduced the wrinkling and dog ear problems to some extent, it also increased the amount of tears in the film. Such over-heating or "burn out" increases the reject ratio of packages and thus raises costs. Further, the heat tunnel requires more energy to operate at a higher temperature.

Some film manufacturers provide film rolls having vent holes that are created in the film during a post production process. This film is designed for wrapping items that need to "breathe" such as crusty breads, leafy food products, and the like, and are generally not used for shrink-wrapping. These vent holes are produced using hot perforators and are relatively large and visible. Further, a roll of such film containing the vent holes is significantly more expensive than a plain roll of shrink-wrap film.

Other problems associated with existing sealing apparatuses include wasted film remaining from the punched holes, and the requirement of a distinct power source, which increases costs and maintenance.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a method and apparatus for providing pores in shrink-wrap through an in-line, on board-system to overcome the short-comings associated with the prior art shrink-wrapping systems.

It is a further object of the present invention to provide a method and apparatus for providing a vast number of minute pores in the shrink-wrap film.

It is a further object of the present invention to provide a method and apparatus for creating pores in a shrink-wrap film which prevents tearing of the film during the shrink-wrap process, and which prevents the subsequent contamination of the package.

It is a further object of the invention to provide an apparatus which can be easily adjusted to vary the position and control the size of the pores.

It is a further object of the present invention to provide a method and apparatus for controlling the rate at which the entrapped air bleeds out of the shrink-wrapped package.

It is a further object of the present invention to provide adequate venting of a package during the heat-shrink process without using any large vent holes.

It is a further object of the present invention to provide a method and apparatus for creating pores in a shrink-wrap film in line with the film path of a wrapping device.

It is a further object of the present invention to provide a method and apparatus which reduce wrinkling in shrink-wrapped packages while decreasing the temperature in the heat shrink tunnel.

It is a further object of the present invention to provide an on-board perforating device for shrink-wrapping machines that does not require a separate power source.

It is a further object of the present invention to provide a venting system that produces a vast number of minute pores in shrink film that are virtually invisible and yet exist along the entire surface of the film to permit uniform air flow from within the package.

In accordance with a first aspect of the present invention, a perforating device is provided for punching pores in shrink-wrap film as it moves along a film path. One embodiment employs a means for creating tension on the film as it passes a microperforator apparatus which is located opposite a rotary brush. The rotary brush biases the film towards the microperforator apparatus which contain a plurality of pins that punch a vast number of minute pores in the film. The microperforating device can be retrofit to existing shrink-wrap film packaging systems, or be fitted to new shrink-wrapping systems. It is designed to be used with shrink-wrapping systems as an in-line, on-board perforating apparatus.

In accordance with a second aspect of the invention, an adjustment apparatus is provided to permit an operator to easily adjust the size of the pores. The rotary brush is preferably adjusted to move closer to the microperforator apparatus if larger pores are to be punched, or moved away from the microperforator apparatus so that smaller holes can be punched. Thus, an operator can control the size of the pores which is the same as controlling the rate at which entrapped air bleeds out of the package. Thus, the temperature of the heat tunnel can be reduced if larger holes are punched.

In accordance with a further aspect of the present invention, the microperforator apparatus comprises a plurality of microperforator pin wheels and gripper wheels on a shaft which can be positioned to produce predetermined patterns of pores on the shrink-wrap film. An operator can use different combinations of microperforator pin wheels and gripper wheels. Thus, the perforator apparatus can be customized to conform to operator requirements regarding the amount and position of pores to be punched. Small pores are virtually invisible on the finished, shrink-wrapped package, and if enough small pores are used then the operating temperature of the heat tunnel can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, aspects and embodiments of the present invention will be described with reference to the following drawings, of which:

FIGS. 1A and 1B are a perspective and a top view, not drawn to scale, of a heat-sealing system employing a perforator apparatus according to the present invention;

FIGS. 2A and 2B are perspective views of an embodiment of a perforator apparatus according to the present invention;

FIG. 3 is a threading diagram of the perforator apparatus of FIGS. 2A and 2B;

FIG. 4 is a front, detailed view of a perforator shaft component and a rotary brush component;

FIGS. 5A, 5B, 5C and 5D are side views of a gripper wheel, a spacer wheel, a perforator pin wheel, and a rotary brush, respectively;

FIG. 5E is a detailed view of a perforator pin;

FIG. 6A is a side perspective view of a housing;

FIG. 6B is a side view of a cam lift lever apparatus;

FIG. 6C is a side view of a microadjustment knob;

FIGS. 7A and 7B are side views of a first and a second drive gear in the open and close positions, respectively;

FIGS. 8A, 8B and 8C are front and side views of a low density, standard, and a high density perforator pin wheel, respectively; and

FIG. 9 is a cut-away side view of another embodiment of the present invention.

DETAILED DESCRIPTION

The present invention will be described in conjunction with a semi-automatic L-sealer system **1** shown in FIGS. **1A** and **1B**, but it will be appreciated that the present invention can be used with other sealing apparatuses as well, such as horizontal form fill wrappers or edge seal wrappers.

FIG. **1A** is a front view, from the perspective of an operator, of a semi-automatic sealing machine **1** supported by legs **3**, and having a film dispenser **15**, a packaging area **7**, a sealing area **9**, a conveyor **4**, and a heat shrinking area **2**. FIG. **1B** is a top view of the sealing machine of FIG. **1A**.

As shown in FIGS. **1A** and **1B**, the film **17** proceeds from right to left, i.e., upstream to downstream. The film dispenser **15** accommodates a roll **16** of pre-folded film **17** (see FIG. **2A**) on rollers **6*a*** and **6*a***. The film **17** is oriented such that its fold is disposed toward the rear as it approaches the packaging area **7** (i.e., to the top of FIG. **1B**). A microperforator apparatus **10** according to the present invention is shown situated in between the film dispenser **15** and the packaging area **7**. A separator **19** (shown in FIG. **2A**), which separates the film **17**, is situated directly downstream of the microperforator apparatus **10**. An item to be wrapped is placed on a feeding plate **21**, located in the packaging area **7**.

The sealing area **9** contains a U-shaped member **25** which is mounted at the rear of the sealing area **9** on a pivot bar **8**, which is pivotally secured at its ends to the L-sealer apparatus. An upper L-shaped seal bar **27** is mounted on the front and to the right side of the U-shaped member **25**, and a lower L-shaped seal bar (not shown) is mounted on the surface of the sealing area **9**. The lower seal bar comes into substantially direct, continuous and uniform contact with the upper seal bar **27** when the latter is in sealing position. Items to be sealed are moved from the feeding plate **21** to the sealing area **9** where an operator uses the L-sealer to seal the loose flaps of the shrink-wrapped item. Packages which have been sealed are then moved along a conveyor **4** to a heat tunnel **28** for heat-shrinking.

In order to understand the utility of the present invention, a brief description of the entire packaging process follows. An operator first loads a roll of shrink-wrap film **16** on the film dispenser **15**, and then threads the film **17** through the microperforator apparatus **10**. (Details concerning the threading of film **17** through the microperforator apparatus, and the components contained therein are explained in detail below.) The operator then pulls the film **17** downstream. The separator **19** causes the layers of folded film to separate. The top layer of film is disposed above the feeding plate **21**, and the bottom layer of film is disposed below the feeding plate **21**. The operator inserts an item to be wrapped between the layers of film by sliding it on the feeding plate beneath the top layer of film. As the film **17** is pulled downstream, it moves through the microperforator apparatus **10** where pores are punched in the film **17** by microperforator pin wheels **36** (shown in FIG. **2B**). In the presently preferred embodiment, about **1000** pores are punched in a section of film that is 12 inches square. A preferred embodiment of a microperforator apparatus **10** according to the present invention punches pores without requiring a separate source of power, and does not use heat to melt or otherwise penetrate the film **17**.

After loosely wrapping the item in shrink-wrap film **17**, the operator moves the package to the sealing area **9** and pushes U-shaped member **25** down, causing the upper seal bar and lower seal bar to engage, to seal and cut the film **17** around the item. The controls found on the console **23** may be used to control the operation of L-sealer apparatus to seal the package. The package is then transported, typically by an automatic conveyor **4**, to the heat tunnel **28**. (Any one of the preceding steps, or all of them, may be performed either manually, semi-automatically or automatically.) Once inside the heat tunnel, the package is heated, and trapped air escapes through the pores punched in the film **17** by the microperforator apparatus **10** as the film **17** shrinks to conform to the item. The package stays in the heat tunnel **28** long enough at a sufficient temperature to shrink the film **17** to form a tightly wrapped package. Because of the large number of pores punched by the present invention, and their placement across the entire surface of the film, the heat shrink tunnel can operate properly at a lower temperature, thus saving energy.

Details concerning the operation of L-sealers do not form a part of the present invention and will not be discussed further herein. Further, the invention could be used with other types of sealers such as horizontal form-fill wrappers or edge seal wrappers.

FIG. **2A** is a perspective view of a microperforator apparatus **10** according to the present invention shown connected to a film dispenser **15**. The microperforator apparatus **10** can be easily retrofit to existing sealing apparatuses, or can be sold as a component of a new machine. The apparatus **10** has a safety cover **30**, preferably made of a transparent plastic material, attached to two housing elements **32**. The safety cover prevents injury from occurring due to contact with the microperforator pin wheels **36** (see FIG. **2B**) which contain sharp conically-shaped pins that function to punch pores in the film **17**. The housing elements **32** support a film separator rod **19**, a film guide roller **20**, and dual microperforator adjustment assemblies **50**.

FIG. **2B** is a detailed perspective view of the microperforator apparatus **10** of FIG. **2A**. A microperforator shaft **33** and a rotary brush shaft **40** are shown mounted between the housings **32**. Connected to the microperforator shaft **33** are a plurality of gripper wheels **34**, spacer wheels **35**, and microperforator pin wheels **36**. Also connected to the microperforator shaft **33** is a first drive gear **38**. A rotary brush **41**, preferably comprised of high-density nylon bristles, is connected to the rotary brush shaft **40** along with a second drive gear **42**. While the brush **41** is preferably comprised of high-density nylon bristles, the brush-could be any stiff material or any roller with a pliable surface, such as polyurethane or a high pile cloth or felt.

FIG. **2B** also depicts two microperforator adjustment assemblies **50** which are mounted to the housing elements **32**. Each assembly **50** comprises a cam lifter lever **51**, a cam lift **53**, spring rods **55**, a knob holder **70** and a micro-adjustment knob **57**. The cam lifts **53** are rotatably mounted to each end of the rotary brush shaft **40**. The micro-adjustment knobs **57** are connected to knob holders **70**, and the spring rods **55** are located inside a channel **56** which runs through the housings **32**.

FIG. **3** is a threading diagram depicting how the film **17** moves through the microperforator apparatus **10**. A roll of pre-folded film **16** is rotatably mounted to the film dispenser **15**. Rollers *6a* and *6b* maintain the film on the roller **16**, guiding it toward the microperforator apparatus **10**. The roller **16** turns in a clockwise direction indicated by arrow "X". The film **17** is fed under a hook brake **8**. When the film is not being pulled, a spring **12** acts to pivot the hook brake **8** counterclockwise about pivot point **13** so that a rubber stop **11** engages roller *6a*, preventing feeding of the film. When the operator pulls the film, film tension causes the hook brake **8** to overcome the bias of spring **12** and to rotate clockwise about the pivot point **13**. The rubber stop **11** then disengages from roller *6a*, permitting dispensing of the film.

Referring to FIG. **3**, a microperforator pin wheel **36** and the rotary brush **41** are shown in cross-section with the film **17** threaded between them. The film **17** proceeds under film guide roller **20**, around separator **19**, and then on to the packaging area **7**. As an operator pulls the film, the film roll **16** turns and film **17** is fed through the microperforator apparatus **10**, and microperforator pin wheel **36** punches pores in the film **17**.

FIG. **4** is a front, detailed view of the microperforator shaft **33** and rotary brush shaft **40** components of the microperforator apparatus **10**. The microperforator shaft **33** has an inner shaft **31**, and the rotary brush shaft **40** has a rotary inner shaft **43** for connection to the housings **32** (see FIGS. **2A** and **2B**). The microperforator shaft **33** may have a "D" shaped cross section, or have a flattened portion running the length of the shaft, so that the microperforator pin wheels **36** and gripper wheels **34** can be fixidly attached. Alternately, the microperforator shaft **33** may have a key way such that the gripper wheels and microperforator pin wheels are fixed to and rotate with the shaft. The first drive gear **38** is fixidly attached to the microperforator shaft **33**, and meshes with the second drive gear **42** which is fixidly attached to the rotary brush shaft **40**.

An arrangement of microperforator pin wheels **36**, gripper wheels **34**, and spacer wheels **35** is shown connected to the microperforator shaft **33**. The pattern of having a spacer wheel **35**, and then a series of alternating gripper wheels **34** and microperforator pin wheels **36**, may be altered depending on customer requirements or on application specific needs. For example, two gripper wheels **34** may be placed side by side between two or more microperforator pin wheels **36**, or a plurality of microperforator pin wheels **36** could be used with only a few gripper wheels **34**. In addition, microperforator pin wheels **36** having different pin densities (see discussion below regarding FIGS. **8A–8C**) could be used in the same microperforator pin apparatus **10**.

FIGS. **5A–D** are side views of a gripper wheel **34**, a spacer wheel **35**, a microperforator pin wheel **36**, and a rotary brush **41**, respectively. The gripper wheel **34**, spacer wheel **35** and microperforator pin wheel **36** are all designed to fit onto microperforator shaft **33**. The microperforator shaft **33** may have a flattened portion to permit one or all of the microperforator pin wheels **36**, gripper wheels **34**, and spacer wheels **35** to be fixidly attached. For example, the microperforator pin wheels **36** may be fitted with set screws designed to contact the flat portion of the shaft **33**. The rotary brush **41** is fixedly mounted on the rotary brush shaft **40**.

FIG. **5E** depicts details of a pin **37** of a type that would be fitted into pre-drilled holes on the microp: -

forator pin wheel **36** of FIG. 5C. It is important to note that the pin **37** has a sharp conical tip **65**. The conical shape of the pin **37** is one factor which permits an operator to adjust the microperforator apparatus **10** to produce pores of different sizes. Although pins **37** do not have to be machined to exact tolerances for the present invention to function properly, if required, sets of identically machined pins can be inserted into the microperforator pin wheel **36** so that exactly the same size holes will be produced for a given setting of the microperforator apparatus **10**.

Referring to FIG. 5A, the gripper wheel **34** has a radius distance "A". Gripper wheel **34** is comprised of an inner wheel **61**, preferably composed of a metal such as aluminum, and an outer gripper wheel **62**, preferably composed of PVC material or the like. FIG. 5B depicts a spacer wheel **35** preferably comprised of aluminum having a radius distance "B". FIG. 5C shows a microperforator pin wheel **36**, preferably made of aluminum, having a radius distance "C", and which contains a plurality of pins **37**. The radius distance "D" equals the distance from the center of the microperforator pin wheel **36** to the tip of any one of the pins **37**. Lastly, FIG. 5D depicts a rotary brush **41** having a radius distance "E".

In order for holes to be correctly punched in the film **17**, the radius distance "A" of gripper **34** should be greater than the radius distance "C" of microperforator pin wheel **36**, and the same or greater than the radius distance "D". This is important because when a sheet of film **17** is fed between the microperforator shaft **33** and the rotary brush shaft **40** as shown in FIG. 3, the film **17** is biased towards the gripper wheels **34** and the microperforator pin wheels **36** by the bristles of rotary brush **41**. The gripper wheels **34** act with the bristles of the brush **41** to provide a lateral tension in the film between adjacent gripper wheels so that the conically-shaped pins **37** on the microperforator pin wheels **36** can easily penetrate the film **17** and push into the voids between bristles of the rotary brush **41**. Thus, the combination of the bristles of the rotary brush **41** and the rubber gripper wheels **34** combine to "freeze" the film **17** between them in the lateral direction as the film is pulled through the microperforator apparatus **10**, which allows the pins **37** to punch pores in the film **17**. The distance between the bristles of the rotary brush **41** and the microperforator pin wheels **36** determines the size of the holes.

Care must be taken to ensure that there is an adequate number of gripper wheels **34** properly spaced across the microperforator shaft **33** so that the film **17** is gripped under tension along its entire lateral length between the gripper wheels and the rotary brush so that tearing problems are avoided. When film is held too loosely, the pins of the microperforator pin wheels **36** push the film, rather than puncturing it. This causes the film to run and may result in tearing. When the film is held in proper tension between the gripper wheels **34** and the rotary brush **41**, the microperforator pin wheels **36** can punch pores in the film without tearing it. Further, because the pins prick many small pores, there is no waste film left loose on a workroom floor.

FIG. 6A is a side view of one of the housings **32** in isolation showing a separator slot **18**, a shaft hole **39**, an oblong slot **45**, a spring rod **55** inside a channel **56**, and a knob holder **70** having threaded slot **71**. Referring to FIGS. 4 and 6A, one side of the microperforator inner shaft **31** fits into shaft hole **39**, and one side of the rotary inner shaft **43** of the rotary brush shaft **40** fits through oblong slot **45**. The cam lifter **53**, shown in FIGS. 2B and 6B, is pivotally mounted to the end of brush shaft **40** about shaft hole **140**. Thus, the rotary brush shaft **40** has a range of positions defined by the oblong slot **45**.

FIG. 6B is a side view of the cam lift lever **51** connected to the cam lift **53**, and FIG. 6C is a side view of the microadjustment knob **57**. These components are fitted on each housing **32** to form the dual microperforator adjustment assemblies **50** of FIG. 2B. (The cam lift **53** is drawn to exaggerate its shape so that its function can be more easily explained.)

The microadjustment knob **57** of FIG. 6C has threads **59** and a screwdriver adjustment slot **58**. The threads **59** of the microadjustment knob **57** fit into the threaded slot **71** of knob holder **70** on housing **32** shown in FIG. 6A. The end **54** of the microadjustment knob **57** protrudes from the bottom of knob holder **70** and contacts the cam lift **53** to set a limit on movement of the cam lift **53**. Thus, an operator can use a screwdriver in slot **58** of each microadjustment knob **57** to adjust the positioning of the rotary brush **41**.

When all components of the microperforator apparatus are connected as shown in FIG. 2B, the rotary brush shaft **40** is biased in an up position by spring rod **55** which rides in channel **56**. A cam lift **53** and a cam lift lever **51** are connected to each side of the rotary inner shaft **43** (shown in FIG. 4). An operator turns the cam lift lever **51** and the microadjustment knob **57** to adjust the distance between the bristles of the rotary brush **41** and the microperforator pin wheels **36**.

The microperforator adjustment assemblies **50** serve two functions. The first involves threading the film, and the second involves controlling the size of the holes punched. Referring to FIG. 3, the microperforator apparatus **10** is shown in the threaded position, i.e., the film **17** is positioned between the rotary brush **41** and the gripper wheels **34**. To thread the film **17** initially, the rotary brush **41** is displaced down, away from the gripper wheels **34**, by rotating the cam lift lever **51**. This causes the cam surface **153** to engage the end **54** of the microadjustment knob **57**. As the cam lift **53** is rotated, brush hole **140** is moved down, pushing that end of the rotary brush shaft **40** down also. When both cam lift levers **51** are rotated down, the rotary brush **41** is removed from the gripper wheels **34**, creating room for film threading.

The microperforator adjustment assemblies **50** could be mounted so that the microperforator shaft **33** is displaced upwards but this would require a larger safety cover **30**. The microperforator could also be mounted under the brush **41**, but this would increase the operator's exposure to the pins **37**.

To adjust the size of the pores to be punched into the film **17**, microadjustment knob **57** is rotated to change the position of the end **54**. Referring to FIGS. 2B and 6A, the spring rod **55** pushes the rotary brush shaft **40** up in slot **45**. This results in cam lifter **53** also being pushed up. The brush shaft **40** is prevented from reaching the top of slot **45** because the cam lifter **53** engages the end **54** of microadjustment knob **57**. When the end **54** is lowered, the cam lifter **53** engages the end **54** at a lower position thus lowering the rotary brush **41**.

This lowering effect is increased because rotation of the cam lifter **53**, which is rotatably mounted to the shaft **40**, is reduced. As the cam lifter **53** is pushed up at shaft hole **140**, it is simultaneously pushed down by microadjustment knob **57** at contact point **253**, resulting in rotation of the cam lifter **53**. The rotation of the cam lifter **53** ceases when cam lifter lever **51** engages knob holder **70**. When the end **54** is lowered, the upward movement of the cam lifter is reduced and greater rotation of the cam lifter lever **51** toward the vertical is permitted. The radius of the cam lifter **53** at point **253** increases as the cam lifter lever **51** rotates toward the vertical. This further limits the upward movement of shaft hole **140**, and thus shaft **40**. Alternately, moving the end **54** to a higher position increases the height of cam lifter **53** as well as reduces the rotation of the cam lifter lever **51**, resulting in the brush being closer to the microperforator shaft **33**.

FIGS. **7A** and **7B** are side views of the first drive gear **38** and second drive gear **42** (shown in FIG. **4**) in their fully open and fully close positions, respectively. The drive gears **38** and **42** mesh together in operation to ensure that the rotary brush shaft **40** and microperforator shaft **33** turn in unison. Other gearing type arrangements, such as the use of tapered friction wheels or a polychord belt arrangement, could be used.

FIG. **7A** depicts the case in which the rotary shaft **40** was adjusted for operation to be furthest away from the microperforator shaft **33** so that the pins **37** of the microperforator pin wheels **36** will not penetrate too deeply into the film **17**. Thus, very small vent holes, or pores will be punched in a sheet of film **17**. FIG. **7B**, however, depicts the case in which the rotary shaft **40** and microperforator shaft **33** are closest together so that the pins **37** will penetrate deeply into the film **17**. Thus, larger pores will result. In general, small vent holes or pores are preferable since the smaller the hole the less visible it will be on the finished, shrink-wrapped package.

The microperforator pin wheels **36** are designed to produce very precise patterns of vent holes or pores in a sheet of film **17**. Further, the pattern of pores can be easily changed by adding or subtracting gripper wheels **34** and microperforator pin wheels **36** to the microperforator shaft **33**. This is advantageous since it may be required to wrap different packages of varying size and shape which may require pores in different locations. Further, if holes are positioned only on some sides of the item, the trapped air on the other sides may burst the film seal or tear the film. Thus, an operator of a heat-sealing machine utilizing a microperforator apparatus **10** according to the present invention can adjust the placement of microperforator pin wheels **36** to produce sufficient pores that will provide adequate venting of trapped air during the film shrinking process. Thus, the operator can control the rate at which entrapped air will bleed out of the package during the heat shrink process. This will result in an energy savings if the heat tunnel temperature can be reduced.

Further, the operator can customize the placement of the vent holes dependent on the item type to be wrapped so that the end product, the heat-sealed package, is presentable. Particularly, the present invention permits vent holes to be punched along the entire film, thus permitting even air flow over the entire package.

FIGS. **8A** to **8C** are front and side views depicting different pin configurations for a microperforator pin wheel **36**. FIG. **8A** shows a low-density microperforator pin wheel **36** having three rows of pins **37** of six pins each, for a total of eighteen pins. FIG. **8B** shows a standard microperforator pin wheel **36** having three rows of pins of eight pins each, for a total of twenty-four pins. Lastly, FIG. **8C** shows a high-density microperforator pin wheel **36** having three rows of pins of twelve pins each for a total of thirty-six pins. Of course, more or less pins may be present, and the microperforator pin wheel **36** may be manufactured to be wider to accommodate more pins, or narrower to accommodate less pins. In addition, it is preferable to set the pins **37** into the microperforator pin wheels **36** in a diamond pattern to ensure an equal distribution of punched holes, and to reduce stresses which could occur while pores are being punched that could lead to tearing of the film **17**. More or less pins may be attached to a microperforator pin wheel based on customer preference or application, and other pin pattern settings could be used as well.

As described above, the present invention permits an operator to adjust the size of the pores to be punched through the film **17**. This flexibility is desirable for a number of reasons. First, the size of the vent holes must be adequate so that air trapped during the sealing process can escape during the shrinking process. Second, the rate at which entrapped air escapes from the package is proportional to the size and number of vent holes available. Third, vent holes which are the wrong size can result in tearing during the film shrinking process resulting in a torn package. Fourth, vent holes which are too small do not permit adequate venting which can result in a torn or wrinkled package. If any of the above problems occur, then the package either must be re-wrapped or discarded which wastes time, materials and money. Since the packaging industry requires a tightly shrink-wrapped finished product that contains a minimum of wrinkles and is not torn, it is highly desirable to be able to control the amount and size of the vent holes so that the shrink-wrapped package appears desirable to consumers.

Further, vent holes which are small in size help prevent contamination of the item within the finished package. For example, small vent holes in shrink-wrapped food items can help prevent insects, dust, and other debris from gaining entry to the package.

FIG. **9** is a cut-away side view of an alternate embodiment according to the present invention. A first pair of rollers **121** are disposed upstream of the rotary brush **41**. A second pair of rollers **120** are disposed downstream of the rotary brush **41**. The rollers **120, 121** are positioned so that they hold the film in tension along its entire length. Both pairs of rollers **120, 121** contain one-way clutches that allow the film to pass between them only in the downstream direction. Because the rollers **120, 121** do not permit the film to move upstream, a tension in the film is maintained. Due to the tension in the film, gripper wheels **34** are not required. Thus, microperforator pin wheels **36** can be mounted all the way across the microperforator shaft **33** to increase the number of pores punched in the film.

Thus, the present invention provides a method and apparatus for punching a vast number of minute pores in shrink film which are virtually invisible in the finished packaged item. The pores can exist along the entire length of the film surface thus permitting uniform air flow out of the package during the shrinking process. As a result, shrink-wrapped packages wrapped using the present invention are pleasing to the eye and protected from contamination.

The microperforator apparatus **10** of the present invention should be disposed along a film path between a film supply and a film pulling source. In the manual or semi-automatic L-sealer described above, the film supply is the roll of shrink-wrap film **16**. The film pulling source is the operator who manually draws the film through the microperforator apparatus **10**. Since the microperforator apparatus **10** is driven by drawing the film, the pins **37** move at the same rate as the film. This prevents the pins **37** from pulling or tearing the film during perforation.

Although described for use with a semi-automatic system, it will be appreciated that the microperforator apparatus **10** can be employed with other types of sealing apparatuses as well. For example, one skilled in the art could design a microperforator apparatus according to the present invention for use with an automatic heat-sealing system. Further, numerous other embodiments and variations of the invention will be apparent to those skilled in the art.

I claim:

1. A method for perforating shrink-wrap film as the film moves along a film path, comprising:

setting at least one microperforator means along a first shaft to punch a desired pattern of holes;

setting the lateral tension of the film by adjusting a plurality of gripper wheels connected to the first shaft;

threading the film between a biasing means connected to a second shaft and the microperforator means;

pulling the film to wrap an item such that the film passes between the biasing means and the microperforator means; and

punching a plurality of pores in the film.

2. The method of claim **1**, further comprising:

adjusting the first shaft so that different size pores will be punched.

3. The method of claim **1**, further comprising:

adjusting the biasing means so that different size pores will be punched.

4. The method of claim **1**, further comprising:

adjusting the microperforator means so that a different pattern of pores will be punched.

5. A perforating device for punching pores in shrink-wrap film as it moves along a film path, comprising:

a first housing;

a plurality of adjustable gripper wheels connected to a perforator shaft which is connected to the first housing, for creating lateral tension on the film between adjacent gripper wheels;

at least one microperforator means connected to the perforator shaft between adjacent gripper wheels and disposed along the film path; and

a biasing means connected to a rotary shaft and disposed along the film path for biasing the shrink-wrap film into the microperforator means.

6. The perforating device of claim **5**, wherein the microperforator means and the biasing means rotate in unison.

7. The perforating device of claim **5**, wherein the biasing means is a rotary brush.

8. The apparatus of claim **5**, further comprising:

a gearing means for connecting the perforator shaft and the rotary shaft.

9. The apparatus of claim **8**, wherein the gearing means comprises:

a perforator gear connected to the perforator shaft; and

a rotary gear connected to the rotary shaft, such that the perforator gear and the rotary gear contact each other during operation so that the rotary shaft and the perforator shaft turn in unison.

10. The apparatus of claim **5**, further comprising:

adjustment means for changing the size of the pores by moving the biasing means either away from or towards the microperforator means.

11. The apparatus of claim **10**, further comprising:

a fine adjusment means connected to the first housing for setting a limit for the distance between the microperforator means and the rotary brush means.

12. The apparatus of claim **5**, wherein the microperforator means comprises a plurality of conical pins.

13. The apparatus of claim **12**, wherein the conical pins are arranged in a diamond pattern.

14. The apparatus of claim **5**, wherein the gripper wheels are made of PVC, polyurethane polyvinyl chloride.

15. The apparatus of claim **5**, wherein the biasing means comprises:

a synthetic brush means connected to the rotary shaft.

16. The apparatus of claim **15**, wherein the synthetic brush means is made of polyester.

17. The apparatus of claim **5**, further comprising:

a safety cover connected to the first housing for preventing injury from the microperforator means.

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